SFS for Prod Lab AID Report 7 Library

AID PASA NO. TA(AG) 03-75

GHANAIAN HARDWOOD MIXTURES FOR PULP AND PAPER

By

JAMES F. LAUNDRIE, Chemical Engineer

UNIVERSITY OF MINNESOTA
APR 12 1977
FORESTRY LIBRARY

February 1977

FOREST PRODUCTS LABORATORY

LIMITED DISTRIBUTION

AID Report No. 7

FOREST PRODUCTS LABORATORY

MADISON, WISCONSIN - 53705

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

In Cooperation with the University of Wisconsin

GHANAIAN HARDWOOD MIXTURES FOR PULP AND PAPER

By

JAMES F. LAUNDRIE, Chemical Engineer

Forest Products Laboratory,[1] Forest Service
U.S. Department of Agriculture

Summary

Kraft pulps, with quality equal to or better than those of North American hardwood kraft pulps, were made using 3 mixtures of 22 Ghanaian hardwood species. The concept of using air classification to obtain improved pulp quality from mixed tropical hardwoods was verified as being feasible. Also varified as being feasible was the idea of using a high-yield kraft process with 25 to 30 percent screenings being used in corrugating medium and the remaining screened pulp for liner-board. Handsheet tests indicate that acceptable quality corrugating medium can also be made from all three mixtures cooked by the neutral sulfite semichemical (NSSC) process. Acceptable quality newsprint can be made from a furnish containing as much as 90 percent Ghanaian hard-wood pulps.

Experimental

Log Processing and Makeup of Mixtures

Twenty-two different species, with a total dry weight of about 4,000 pounds, were harvested in Ghana. This wood resource, covering a

---

[1] Maintained in Madison, WI, in cooperation with the University of Wisconsin.

range of densities and colors, was received by the Forest Products Laboratory (FPL) in June 1976. Upon receipt of the logs by the FPL, they were immediately placed into cold storage, where they, and the chips produced, remained until needed for further processing. A 1-foot length was cut from the butt log of each species to provide material for botanical studies. One-inch disks were also cut from each log for the determination of specific gravity. The identification of each species was also verified.

All of the logs were peeled and converted into nominal 5/8-inch chips, keeping each individual species separate. The bark was used in another study to determine calorific value and other potential uses. The chips were screened, and the amounts of oversize (+1-1/4 inch) and undersize (-1/4 inch) were determined. Samples of chips from each species were analyzed for ash and silica. For exploratory kraft and NSSC digestions, mixtures of the screened chips were made to simulate three potential naturally occurring density distributions. Chemical analyses were made on samples of the three mixtures to determine ash, silica, pH, lignin, and extractives. For pilot-scale kraft digestions, a larger quantity of only mixture A was made. A mixture containing equal quantities of only the four lightest colored and lowest density woods was made for the production of a pilot-scale thermomechanical pulp.

Separation of a Chip Mixture

Previous work with the Philippine hardwood mixtures showed that the higher specific gravity woods could be separated from the mixtures to provide fuel for powering the processing equipment, with an expected improvement in the quality of the pulp from the remaining chips. In

order to verify the earlier results, chip mixture A was air classified using an arbitrary specific gravity of 0.45 as the separation point to obtain two weight fractions corresponding to the composition of the mixture.

Exploratory Kraft Pulping

Kraft pulps having less than 1 percent screenings were made using the three mixtures and the air-classified fractions from one mixture. Kraft digestions were also made using the three mixtures to yield pulps having 25 to 30 percent screenings. These digestions were made to verify the feasibility of using the screened pulp for linerboard and the screenings for corrugating medium. The screenings were refined to about 350 milliliters (Canadian Standard freeness) in a 12-inch-diameter, single-rotating disk mill and made into handsheets having a basis weight of 26 pounds per 1,000 square feet. Strength development of the screened pulps was in a Valley beater, and handsheets were made and evaluated according to standard TAPPI methods.

Exploratory NSSC Pulping

NSSC pulping conditions were established to produce pulps with yields of about 75 percent from each mixture. These pulps were refined to about 350 milliliters (Canadian Standard freeness) in a 12-inch-diameter, single-rotating disk mill and made into handsheets having a basis weight of 26 pounds per 1,000 square feet.

Pilot-Scale Kraft Pulping

Four pilot-scale digestions of mixture A were made under the following conditions:

(1) 16 percent active alkali.

(2) 25 percent sulfidity.

(3) 4-to-1 water-to-wood ratio.

(4) 90 minutes to raise the temperature to 170° C.

(5) 90 minutes at 170° C.

Each digestion was blown, and the resulting pulps were washed, screened through a 0.012-inch slotted flat screen, and wet lapped. The pulps from the first two digestions were combined for CEH bleaching and had a composite Kappa number of 20.9. The remaining two pulps were combined for CEDED bleaching and had a composite Kappa number of 22.8.

Pilot-Scale Thermomechanical Pulping

The mixture of light-colored chips was converted into a thermomechanical pulp at the pilot plant of C. E. Bauer, Springfield, Ohio. After an initial 2-minute steaming at 30 pounds per square inch gage, the chips were fiberized to about 400 milliliters (Canadian Standard freeness) in a 418 pressurized refiner. This high freeness pulp was returned to the FPL where it was further refined in a 36-inch-diameter, double-rotating disk mill to 120 milliliters (Canadian Standard freeness) to develop optimum properties for use in newsprint.

Pilot-Scale Bleaching

Two pilot-scale bleaches were made of the kraft pulps. In the first, CEH was used to produce a semibleached pulp for use in the newsprint paper machine trials. In the second, CEDED was used to produce a bleached market-type pulp. The thermomechanical pulp was bleached with hydrogen peroxide before using in the newsprint paper machine trials.

Papermaking

Newsprint weighing approximately 32 pounds per 3,000 square feet (52 grams per square meter) was produced on an experimental Fourdrinier paper machine from a furnish consisting of 70 percent of the Ghanaian hardwood bleached thermomechanical pulp, 20 percent Ghanaian hardwood bleached kraft pulp, and 10 percent commercial western softwood bleached kraft pulp. The hardwood kraft pulp was refined in a pump-through disk refiner to a Canadian Standard freeness of 600 milliliters, and the softwood kraft pulp was refined in the same equipment to 610 milliliters. After blending of the three pulps in the machine chest, the pH of the furnish was adjusted to 5.5 with sulfuric acid and alum. Two newsprint papers were made--one without dye and the other with a dye added approaching the "tint" of commercial newsprint.

Results

Properties of Individual Species and Mixtures

The specific gravity, ash, and silica contents of the individual species are given in table 1. The specific gravity ranged from a low of 0.241 to a high of 0.808. Ash contents ranged from 0.25 to 3.62 percent, while silica contents ranged from none to a high of 0.52 percent.

The amounts of the individual species in the three mixtures are given in table 2. Mixture A contains an even distribution of all species, mixture B is weighted with more of the high-density species, and mixture C is weighted with more of the intermediate density species. The weighted average specific gravity of the three mixtures is 0.470, 0.604,

and 0.487, respectively. As shown in table 3, there were only small differences in the results of chemical analysis of the three mixtures.

Air Classification of Chip Mixture A

Mixture A contained 50 percent chips having a specific gravity of less than 0.45. The amount of air passing through the air classifier was adjusted to obtain this amount of chips in the light fraction. Samples of the chips in both the light and heavy fractions were identified to determine the efficiency of separation, which is defined as the percentage of desirable chips in that fraction. The average efficiency for both fractions was nearly 75 percent.

Quality of Exploratory Kraft Pulps

As shown in table 4, similar yields and Kappa numbers were obtained from all three mixtures and the light and heavy fractions of mixture A.

There were only small differences in the quality of the fully cooked kraft pulps made from the three mixtures (table 5). The strength properties of these pulps were equal to or better than those of North American hardwood kraft pulps and comparable to previous results found with the mixtures of tropical hardwoods from the Philippines. The screened pulps from the digestions made to give high percentages of screenings had bursting and tensile strengths only slightly less than those of the fully cooked kraft pulps but had a loss in tearing resistance of about 10 percent. Larger pulp quality differences were found when pulps from the air-separated fractions were compared. The pulps made from the fraction containing chips having a specific gravity of less

than 0.45 had 10 to 20 percent higher bursting and tensile strengths and 10 to 20 percent lower tearing resistance compared to the pulps made from the fraction containing chips greater than 0.45 specific gravity. These results again verify that air classification is one viable means of improving the quality of pulps from mixed tropical hardwoods.

Quality of Exploratory NSSC and Kraft Screenings Pulps

The conditions and results of the NSSC digestions of the three mixtures are given in table 6. As was found in kraft pulping, the differences between the three mixtures in their response to NSSC pulping are small.

Based on handsheets made from these small-scale NSSC digestions (table 7), it appears that acceptable quality corrugating medium could be made from mixtures A and C cooked to about 72 percent yield by the NSSC process. Handsheets of the kraft screenings pulps also indicate that mixtures A and C would produce acceptable quality corrugating medium. With mixture B, both the NSSC and kraft pulping conditions need to be changed in order to obtain lower yields and comparable handsheet results.

Response to Bleaching and Quality of Bleached Pulps

The conditions and results of the pilot-scale CEH and CEDED bleaches of the kraft pulps are given in table 8. The CEH bleached kraft pulp had a brightness of 76.0 percent and a viscosity of 7.6 centipoises. Bleaching with CEDED gave a bleached pulp with a brightness of 85.0 percent and a viscosity of 10.2 centipoises.

Handsheet properties of both the unbleached exploratory and the pilot-scale bleached pulps are given in table 9. The unbleached pilot-scale kraft pulps were inadvertently bleached before it was discovered that unbleached pulp samples were not taken for testing. However, compared to the unbleached exploratory kraft pulp, both the CEH and the CEDED bleached pulps were 10 to 20 percent lower in bursting and tensile strengths. The tearing resistance of the CEH bleached pulp was also about 20 percent lower, while the tearing resistance of the CEDED bleached pulp was about the same as the unbleached exploratory kraft pulp. Drying of the CEDED bleached pulp on the paper machine caused a loss in all strength properties of about 10 percent.

Even with the above losses, the CEDED bleached pulp was equal to or better than the two bleached kraft market pulps made from North American hardwoods grown in different areas (machine run No. 7155).

The conditions and results of the pilot-scale peroxide bleach of the thermomechanical pulp are given in table 10. Using 0.75 percent hydrogen peroxide, this pulp was bleached from 46.0 to 66.8 percent brightness. Handsheet properties of the bleached thermomechanical pulp given in table 11 show that this pulp is of good quality and should be suitable for use in newsprint and other papers containing mechanical pulps.

Quality of Newsprint

Properties of the experimental newsprints are presented in table 12. Samples of the papers are included in this report. For

comparison, properties of Canadian newsprint and newsprint from Southern United States pines have been included in the table.

The experimental newsprint papers had good strength characteristics generally in the range of newsprint made in Canada and the United States. While their opacity was not as high, their scattering power in terms of scattering coefficient was as good as the reference papers. While no actual printing evaluations were made, their smoothness and air resistance values indicate that this should present no problem.

Conclusions

(1) The strength properties of the kraft pulps made from all three mixtures were equal to or better than those of North American hardwood kraft pulps.

(2) The concept of using air classification to obtain improved pulp quality from mixed tropical hardwoods was verified as being feasible.

(3) It appears that acceptable quality corrugating medium could be made from mixtures A and C cooked to 72 percent yield by the NSSC process. Mixture B requires cooking to a lower yield.

(4) The concept of using only one high-yield kraft pulping process with 25 to 30 percent screenings for use in the manufacture of corrugating medium and the screened pulp for linerboard was verified as being feasible.

(5) Kraft pulp from a mixture of Ghanaian hardwoods can be semi-bleached using CEH and fully bleached using CEDED to provide a strong market grade of pulp.

(6) A good quality thermomechanical pulp can be made from the four Ghanaian hardwoods but requires bleaching for use in newsprint.

(7) Acceptable quality newsprint can be made from a furnish containing 70 percent bleached Ghanaian hardwood thermomechanical pulp, 20 percent bleached Ghanaian hardwood kraft pulp, and 10 percent Western United States softwood bleached kraft pulp. This newsprint furnish requires the addition of dye to approach the "tint" of North American newsprints.

Table 1.--Specific gravity, ash, and silica content of 22 Ghanaian hardwoods

	Species		Specific gravity	Ash[2]	Silica[2]
No.	Common name	Botanical name			
				Pct	Pct
1	Otu	Cleistopholis patens	0.241	1.24	0.02
2	Effeu	Hannoa kleineana	.283	.92	.02
3	African corkwood	Musanga cecropioides	.301	.81	.04
4	Obeche	Triplochiton scleroxylon	.302	2.24	.01
5	Antiaris	Antiaris africana	.312	1.65	.20
6	Canarium	Canarium schweinfurthii	.337	1.11	.30
7	Akoret	Discoglypremna caloneura	.370	1.75	.01
8	African mahogany	Khaya ivorensis	.413	.54	< .01
9	Dahoma	Piptadeniastrum africanum	.442	.75	.02
10	Gedu nohor	Entandrophragma angolense	.450	1.16	< .01
11	Niangon	Tarrietia utilis	.460	.53	< .01
12	Scented guarea	Guarea cedrata	.485	1.27	.11
13	Makore	Tieghemella heckelii	.499	.55	.16
14	Tallow tree	Allanblackia floribunda	.540	1.73	< .01
15	Lokonfi	Celtis adolphi-friderici	.549	1.41	.01
16	Brown sterculia	Sterculia rhinopetala	.552	2.75	< .01
17	Eyong	Sterculia oblonga	.589	2.47	< .01
18	Adjouba	Dacryodes klaineana	.692	1.41	.52
19	Afina	Strombosia glaucescens	.697	1.54	.01
20	Kane	Anogeissus leiocarpus	.708	3.62	.09
21	Kokoti	Anopyxis kleineana	.721	.25	< .01
22	Ekki	Lophira alata	.808	.45	< .01

[1] Dry-weight, green volume basis.

[2] Moisture-free wood basis.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 2.--Composition of 3 mixtures of 22 Ghanaian hardwoods

Species[1]	Specific gravity range	Mixture composition[2]		
		A	B	C
		Pct	Pct	Pct
1 - 4	0.241 - 0.302	16.67	2	4
5 - 7	.312 - .370	16.67	4	8
8 - 10	.413 - .450	16.67	9	20
11 - 13	.460 - .499	16.67	15	40
14 - 17	.540 - .589	16.67	20	20
18 - 22 ,	.692 - .808	16.67	50	8

[1] See table 1 for names of the individual species.

[2] Moisture-free wood basis.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 3.--Chemical analysis of Ghanaian chip mixtures

Mixture	pH	Ash[1]	SiO_2[1]	Extractives[1]			Lignin[1]
				Ethyl-ether	Alcohol-benzene	Hot water	
		Pct	Pct	Pct	Pct	Pct	Pct
A	5.63	1.26	0.08	0.51	4.07	2.76	26.64
B	5.23	1.47	.08	.10	3.32	2.38	27.72
C	5.65	1.16	.06	.46	4.07	2.50	25.62

[1]Moisture-free wood basis.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 4.--Kraft pulping[1] of mixtures of Ghanaian hardwoods

Mixture fraction	Digestion No.	Time at 170° C	Black liquor		Yield[2]		Kappa number
			NaOH (Na_2O)	Na_2S (Na_2O)	Total	Screenings (10-cut)	
		Min	G/l	G/l	Pct	Pct	
			MIXTURE A				
Whole	6050X	90	5.1	5.3	45.8	0.6	26.0
Do.....	6063X	15	6.1	7.6	50.7	21.0	52.3
Do.....	4583, 4584	90	--	--	--	--	20.9
Do.....	4585, 4586	90	--	--	--	--	22.8
Lights[3]	6061X	90	2.9	7.3	45.5	.4	23.8
Heavies[4]	6062X	90	2.3	7.1	44.7	.6	26.3
			MIXTURE B				
Whole	6051X	90	3.1	7.1	43.5	.6	27.5
Do.....	6064X	15	7.1	7.8	49.6	19.0	54.8
			MIXTURE C				
Do.....	6052X	90	2.9	7.6	44.6	.4	22.0
Do.....	6065X	15	6.3	7.6	48.2	17.1	46.3

[1] Constant conditions used were 16.0 pct active alkali, 25 pct sulfidity, 4-to-1 liquor-to-wood ratio, and 90-min rise from 80° to 170° C.

[2] Moisture-free wood basis.

[3] Air classified, less than 0.45 specific gravity.

[4] Air classified, greater than 0.45 specific gravity.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 5.--Properties of screened exploratory kraft pulps made from mixtures of Ghanaian hardwoods

Mixture fraction	Digestion No.	Pulp properties				Handsheet properties					
		Kappa number	Average fiber length	Coarseness	Fibers per gram	Freeness (Canadian Standard)	Beating time	Burst factor	Tear factor	Breaking length	Apparent density
			Mm	Mg/100 m	$\times 10^{-5}$	Ml	Min			Km	G/cm^3
					MIXTURE A						
Whole	6060X	26.0	1.12	9.8	105.5	640	0	25.3	125.1	5.8	0.54
						550	9	50.0	129.5	8.8	.60
						350	27	82.0	118.5	12.2	.69
Do...	6063X	52.3	--	--	--	690	0	17.2	115.1	4.2	.52
						550	18	60.0	129.0	9.9	.64
						350	37	77.0	116.0	12.0	.67
Lights	6061X	23.8	--	--	--	625	0	34.6	151.5	6.6	.57
						550	9	60.0	140.0	8.8	.62
						350	28	85.5	118.0	12.8	.70
Heavies	6062X	26.3	--	--	--	660	0	22.6	136.3	5.3	.51
						550	11	45.5	143.5	8.4	.56
						350	26	69.5	139.0	10.5	.63
					MIXTURE B						
Whole	6051X	27.5	1.32	12.9	77.8	690	0	16.9	115.1	4.6	.49
						550	13	47.0	148.0	8.2	.53
						350	27	67.0	138.0	10.3	.60
Do...	6064X	54.8	--	--	--	705	0	13.1	92.1	3.7	.47
						550	15	48.0	128.0	8.2	.56
						350	28	64.0	124.0	10.0	.61
					MIXTURE C						
Do...	6052X	22.0	1.33	19.0	42.0	620	0	33.8	156.4	6.8	.56
						550	8	62.0	139.5	9.5	.62
						350	24	91.0	112.5	12.5	.70
Do...	6065X	46.3	--	--	--	675	0	22.0	124.0	5.6	.52
						550	14	48.5	125.0	8.8	.58
						350	31	68.0	124.5	11.0	.66

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 6.--NSSC pulping[1] of mixtures of Ghanaian hardwoods

Digestion No.	Spent liquor		Yield[2]
	Na_2SO_3	pH	
	G/1		Pct
	MIXTURE A		
2529Y	21.9	8.1	72.5
	MIXTURE B		
2530Y	24.1	8.0	74.0
	MIXTURE C		
2531Y	23.4	8.0	72.3

[1] Constant conditions used were 16 pct Na_2SO_3, 4 pct Na_2CO_3, 3.5-to-1 water-to-wood ratio, 15-min steaming at 15 lb/in^2g, 120-min rise from 80° to 175° C, and 60 min at 175° C.

[2] Moisture-free wood basis.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Mixture	Digestion No.	Freeness (Canadian Standard)	Basis weight (air-dry basis)	Thick-ness	Burst factor	Tear factor	Breaking length	Apparent density	Ring crush	Concora
		Ml	Lb/1,000 ft^2	Mils			M	G/cm^3	Lb	Lb
				NSSC						
A	2529Y	340	27.0	9.9	30.1	70.9	6,260	0.47	70.4	63.0
B	2530Y	335	26.3	9.7	22.1	64.8	4,870	.47	56.6	57.4
C	2531Y	340	26.0	9.2	30.3	81.2	6,695	.49	51.4	66.4
				SCREENINGS FROM HIGH-YIELD KRAFT						
A	6063X	335	26.1	8.5	45.8	123.7	8,040	.53	66.4	60.8
B	6064X	355	26.4	9.9	30.7	117.7	6,135	.46	58.0	56.4
C	6065X	345	23.9	7.9	57.4	149.1	9,145	.58	73.4	74.2

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Stage No.	Bleach No.	Chemical			Temperature	Consistence	Time	pH		Brightness	Viscosity
		Name	Amount applied	Amount consumed				Initial	Final		
			Pct	Pct	°C	Pct	Min			Pct	cP
1	6813[1]	Chlorine	5.0	4.5	23	1.2	60	3.5	3.4	--	--
1	6815[2]	....do....	5.0	4.6	25	2.9	60	2.9	2.8	--	--
2	6813	Sodium hydroxide	2.0	--	71	10.0	60	11.5	11.4	--	--
2	6815	....do....	2.0	--	72	13.2	60	11.3	11.1	--	--
3	6813	Sodium hypochlorite	1.0	1.0	38	9.6	240	11.1	10.2	76.0	7.3
3	6815	Chlorine dioxide	.6	.6	70	2.8	75	--	6.8	--	--
4	6815	Sodium hydroxide	1.0	--	50	13.7	60	11.8	11.7	--	--
5	6815	Chlorine dioxide	.3	.3	75	2.8	75	--	6.6	85.0	10.2

[1]Blend of 2 pilot-scale digestions with a composite Kappa number of 20.9.

[2]Blend of 2 pilot-scale digestions with a composite Kappa number of 22.8.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Kraft pulp type	Handsheet properties						Pulp properties	
	Freeness (Canadian Standard)	Beating time	Burst factor	Tear factor	Breaking length	Apparent density	Bright-ness	Viscosity
	Ml	Min			Km	G/cm^3	Pct	cP
Unbleached	640	0	25.3	125.1	5.8	0.54	--	--
	550	9	50.0	129.5	8.8	.60	--	--
	350	27	82.0	118.5	12.2	.69	--	--
Bleached--CEH	505	0	40.5	101.7	6.5	.64	76.0	7.3
	350	18	66.5	86.5	9.3	.71	--	--
Bleached--CEDED	565	0	25.0	118.2	4.4	.62	85.0	10.2
	550	3	30.0	122.0	4.8	.63	--	--
	350	19	58.0	121.0	8.5	.71	--	--
Bleached--CEDED (paper machine dried)	585	0	15.4	100.3	3.4	.58	--	--
	550	6	22.0	111.5	4.3	.60	--	--
	350	27	48.0	117.0	7.4	.68	--	--
Bleached market pulp (Southern U.S. hardwoods--dried)	680	0	10.6	99.6	3.0	.55	89.4	11.2
	550	18	35.5	117.0	6.4	.64	--	--
	350	35	55.0	110.0	8.1	.69	--	--
Bleached market pulp (eastern Canadian hardwoods--dried)	565	0	12.1	72.1	2.7	.60	88.9	11.2
	550	3	14.0	73.0	3.1	.61	--	--
	350	36	37.0	81.0	6.1	.71	--	--

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 10.--Bleaching of mixed Ghanaian hardwood thermomechanical pulp for use in newsprint trials

Chemical:[1]		
Name		H_2O_2
Amount applied	pct	0.75
Amount consumed	pct	0.68
Temperature	°C	75
Consistence	pct	11.9
Duration	min	260
pH:		
Initial		10.9
Final		9.8
Brightness:		
Original	pct	46.0
Final	pct	66.8

[1]Additional chemicals were 3 pct $NaSiO_3$, 2 pct NaOH, and 0.05 pct $MgSO_4$.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 11.--Handsheet properties of mixed Ghanaian hardwood thermomechanical pulp used in newsprint trials

Freeness (Canadian Standard)	ml	120
Burst factor		13.7
Tear factor		40.6
Breaking length	km	3.5
Apparent density	g/cm^3	0.54
Brightness	pct	66.8
Scattering coefficient		662
Opacity	pct	90.8

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 11.--Handsheet properties of mixed Ghanaian hardwood thermomechanical pulp used in newsprint trials

Freeness (Canadian Standard)	ml	120
Burst factor		13.7
Tear factor		40.6
Breaking length	km	3.5
Apparent density	g/cm^3	0.54
Brightness	pct	66.8
Scattering coefficient		662
Opacity	pct	90.8

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705

Table 12.--Properties of newsprint papers

Machine run No.	[1]7151	[1,2]7152	Canadian	Southern U.S.
Weight:				
Square meter....g	52.2	47.2	55.5	59.0
(24 x 35, 500)....lb	32.1	29.0	34.1	36.3
Thickness....mils	3.1	2.9	3.5	3.5
Density....g/cm^3	0.66	0.63	0.62	0.61
Bursting strength....pts	11.6	9.8	6.0	9.6
Tearing resistance:				
Machine direction....g	22.0	20.2	14.6	35.0
Cross direction....g	30.2	25.8	20.8	40.2
Tensile strength:				
Machine direction....p.i.w.	14.7	12.7	10.7	12.0
Cross direction....p.i.w.	7.8	6.7	4.6	6.3
Opacity....pct	83.6	83.0	91.2	93.1
Scattering coefficient....	507	483	456	486
Brightness (Elrepho)....pct	66.0	63.8	54.6	57.6
Air resistance (Gurley)...sec/100 cm^3	35.2	28.2	16.7	55.5
Smoothness (Bekk):				
Wire....sec	34.7	31.4	25.5	23.2
Felt....sec	29.1	32.1	31.0	22.7

[1]Furnish: 70 pct Ghanaian hardwood bleached thermomechanical pulp, 20 pct Ghanaian hardwood bleached kraft pulp (refined in pump-through disk refiner to a Canadian Standard freeness of 400 ml), and 10 pct western softwood bleached kraft pulp (refined in pump-through disk refiner to a Canadian Standard freeness of 610 ml).

[2]Dye added to furnish.

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture
Madison, WI 53705